TECHNICAL HANDBOOK
MQ Power Supplies

Components ITT

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MP MASTER

MA23297

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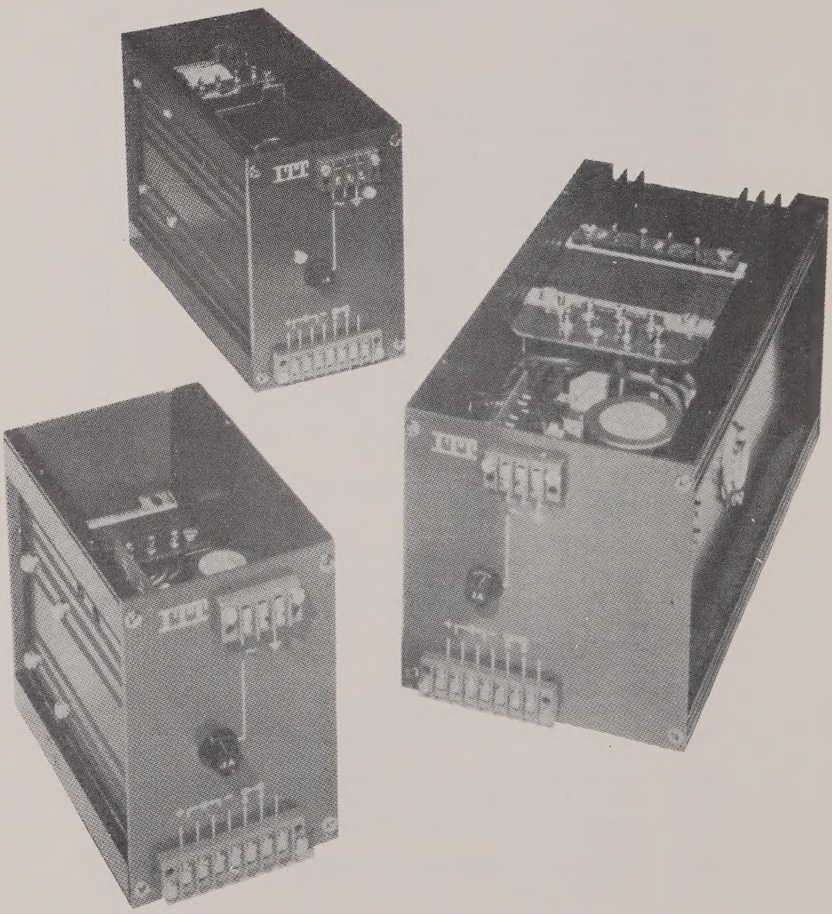


INTRODUCTION

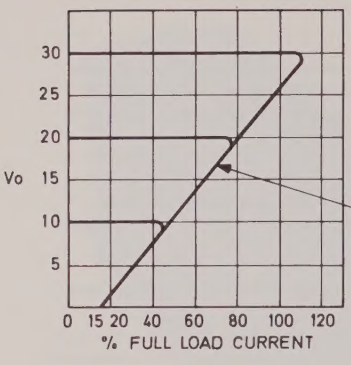
The MQ series of Industrial and Professional modular power supplies provides d.c. supplies of 0.5, 1, 2, 3, 5 and 10 amperes in the range of 0-16 volts or 0-30 volts. The 10 ampere unit is available in the range of 0-16 volts only.

The stabilised output may be preset to any value in the voltage range of the unit or may be programmed by an external resistor if so specified. The board-mounted potentiometer will provide approximately a 10% variation about the preset value.

All the units are of modular construction, supplied in widths suitable for standard equipment practice rack mounting. The basic power supply is identical for both Industrial and Professional units. Conversion from one type to the other is achieved by changing the plug-in control board. The professional control board provides improved line stability, output ripple and d.c. resistance.

Silicon devices are used throughout and the units are fully protected against overload by a circuit which automatically reduces both output voltage and current (otherwise known as foldback or re-entrant current limit). Manual reset following a current overload trip is additionally available on Professional units.

Overvoltage protection is available for both the Industrial and Professional units.



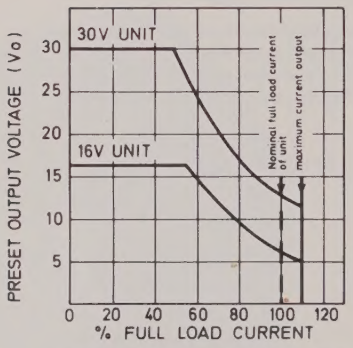
A

FOLDBACK CHARACTERISTICS FOR TYPICAL 30V UNIT

THIS CURVE APPLIES AS DRAWN FOR A PROGRAMMED UNIT

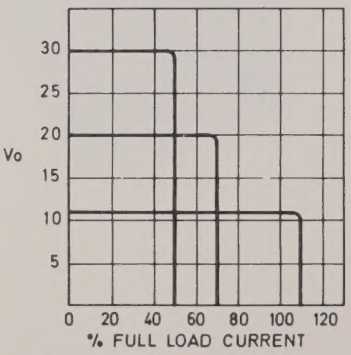
PRESET UNITS FOLDBACK FROM 110% FULL LOAD AT PRESET OUTPUT VOLTAGE

NOTE THAT OUTPUT CURRENT CAPABILITY IS AUTOMATICALLY REDUCED AS THE PROGRAMMED OUTPUT VOLTAGE IS DECREASED



B

DERATING CURVE FOR CONSTANT CURRENT OVERLOAD



C

FAMILY OF CURVES FOR 30V UNIT SET UP FOR CONSTANT CURRENT OVERLOAD

FIG. 1 - TYPICAL CURRENT OVERLOAD CHARACTERISTICS

TECHNICAL DATA

Mains Input:	110V, 220V, 240V ± 10% a.c. 48-440 Hz	
Output Voltage:	Set to any value in the range, or programmable. (See "Ordering Codes" – Fig.3)	
Output Current:	0.5A, 1A, 2A, 3A, 5A (at 0-16V or 0-30V). 10A (at 0-16V only)	
	Professional (10,000:1)	Industrial (1000:1)
Line Stability: (10% input change)	10μV/Vout + 30μV	50μV/Vout + 130μV
Load Regulation: (zero to full load)	10μV/Vout + 60μV	150μV/Vout + 800μV
Ripple and Noise:	200μV peak to peak	500μV peak to peak
Output Impedance:	Less than 250mΩd.c. to 250KHz	
Recovery Time:	Less than 20μs for 50% load change	
Temp. Coefficient:	0.03%/^{o}C (0.005%/^{o}C to special order)	
Insulation:	Output may be floated up to 250V d.c. from earth potential	
Ambient Temperature:	-10^{o}C to +65^{o}C operating -20^{o}C to +85^{o}C storage	
Reverse Polarity Protection:	All units accept reverse current equal to rating of unit (except the MQ5A which should be restricted to 3A).	
Overcurrent Protection:	Current limiting starts at 110% of full load and folds back to about 15% at short circuit. Constant current limiting is optional. Units recover automatically but manual reset after overload trip is available on Professional units.	
Overvoltage Protection:	Optional extra. Trip point set approximately 110% + 0.5V of preset voltage. Protection circuit automatically tracks preset or programmed output voltage.	
Efficiency: $\left(\frac{\text{Output Watts}}{\text{Input Watts}}\right)$	Normally between 30% and 60% depending upon output voltage.	

Outline Dimensions

4 Fixings Top and Bottom
Tapped 4BA x 3/16"

Terminal Block Projection
beyond Front Panel 3/8"

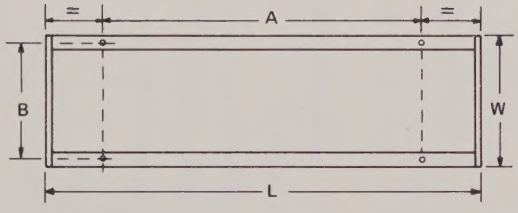
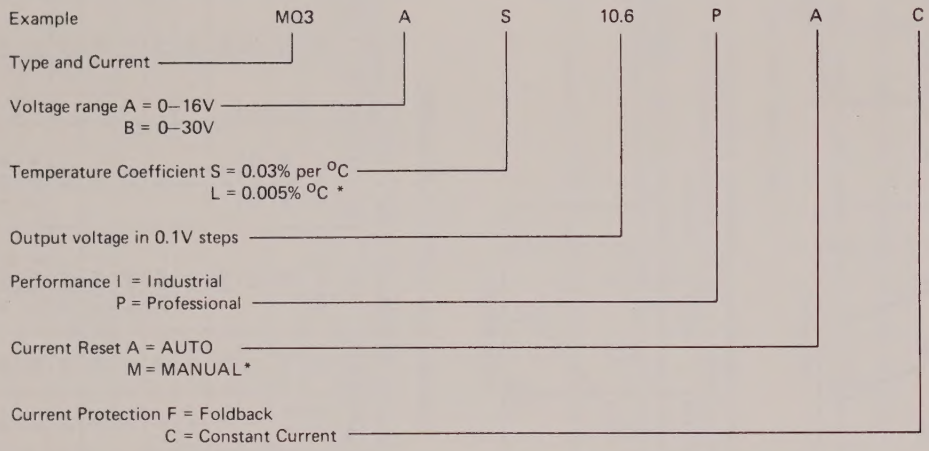


Fig.2 Outline Dimensions

Overall Dimensions and Fixing Centres

Type	Height H		Width W		Length L		Fixing Centres A		Fixing Centres B		Weight	
	mm.	in.	mm.	in.	mm.	in.	mm.	in.	mm.	in.	kg.	lb.
MQ0.5A	127	5	82.6	3¼	82.6	3¼	34.9	1 3/8	76.2	3	1.09	2.4
MQ0.5B	127	5	82.6	3¼	130.2	5 1/8	54	2 1/8	76.2	3	1.53	3.38
MQ1A	127	5	82.6	3¼	130.2	5 1/8	54	2 1/8	76.2	3	1.53	3.38
MQ1B	127	5	82.6	3¼	177.8	7	133.4	5¼	76.2	3	2.39	5.28
MQ2A	127	5	82.6	3¼	177.8	7	133.4	5¼	76.2	3	2.39	5.28
MQ2B	127	5	117.5	4 5/8	247.7	9¾	168.3	6 5/8	109.5	4 3/8	3.50	7.73
MQ3A	127	5	117.5	4 5/8	247.7	9¾	168.3	6 5/8	109.5	4 3/8	3.50	7.73
MQ3B	127	5	117.5	4 5/8	247.7	9¾	168.3	6 5/8	109.5	4 3/8	4.12	9.1
MQ5A	127	5	117.5	4 5/8	247.7	9¾	168.3	6 5/8	109.5	4 3/8	4.12	9.1
MQ5B	127	5	185	7¼	235	9¼	133	5¼	178	7	7.05	15.5
MQ10A	127	5	185	7¼	235	9¼	133	5¼	178	7	7.05	15.5

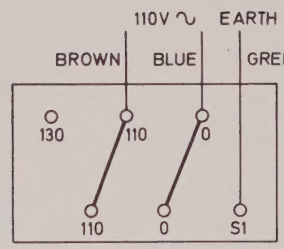
Ordering Codes



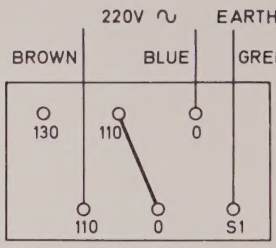
For overvoltage protection add Suffix "O"

*Manual Reset and low temperature coefficient only available with the professional version

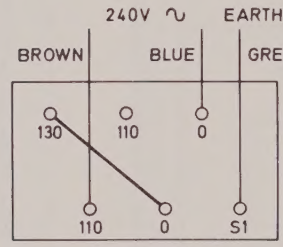
Fig.3 Ordering Codes



110V INPUT



220V INPUT



240V INPUT

MAINS TRANSFORMER PRIMARY CONNECTIONS

PRIMARY AND OUTPUT FUSE RATINGS

UNIT CODE	MAX. D.C. OUT		PRIMARY FUSE (FS1)		EXTERNAL D.C. OUTPUT FUSE
	AMPS	VOLTS	110V	220 / 240V	
MQ 0·5A	0·5	16	500m A	250m A	1A
MQ 0·5B	0·5	30	1A	500mA	1A
MQ1A	1	16	1A	500mA	2A
MQ1B	1	30	2A	1A	2A
MQ2A	2	16	2A	1A	3A
MQ2B	2	30	3·15A	2A	3A
MQ3A	3	16	3·15A	2A	4A
MQ3B	3	30	3·15A	2A	4A
MQ5A	5	16	3·15A	2A	7A
MQ5B	5	30	6·3A*	3·15A	7A
MQ10A	10	16	6·3A*	3·15A	12A

PRIMARY FUSE TO BE 20x5mm ANTI-SURGE I.E.C. 127 AND BS. 4265 *DIN 41571

D.C. OUTPUT FUSE TO BE FAST ACTING TYPE

FIG. 4 - MAINS TRANSFORMER PRIMARY CONNECTIONS AND FUSE RATINGS

PRE-INSTALLATION CHECKS

1. Check for damage which may have occurred during transit.

2. Check that the mains transformer primary connections are suitable for the supply to be used. (See Fig.4).

3. Check that the rating of FS1 is correct by referring to Fig.4.

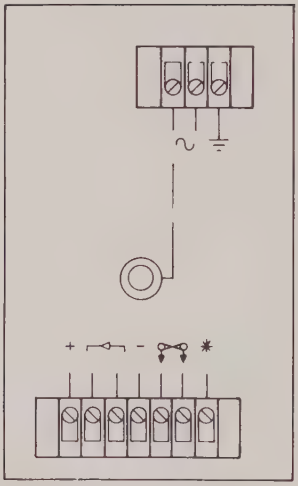
4. Check that the mains supply voltage is within ±10% of the appropriate value shown in Fig.4.

INSTALLATION AND MOUNTING

The unit can be secured by 4BA screws using the tapped holes in the upper or lower edges of the black anodised side extrusions which form the heat sinks.

As the unit is cooled by convection it is important to mount it with the extrusions vertical in order to permit unrestricted airflow through and past the unit.

At full load the surrounding air temperature must not be allowed to rise above 65^{o}C.



FRONT PANEL ENGRAVING

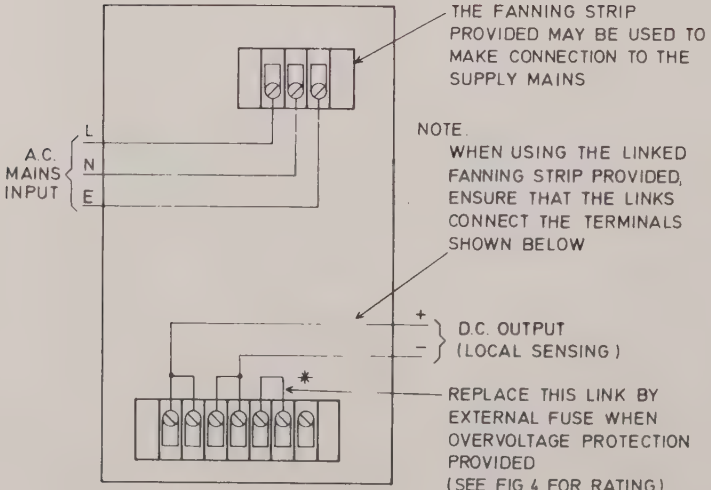

THE FANNING STRIP PROVIDED MAY BE USED TO MAKE CONNECTION TO THE SUPPLY MAINS
A.C. MAINS INPUT
L
N
E
NOTE.
WHEN USING THE LINKED FANNING STRIP PROVIDED, ENSURE THAT THE LINKS CONNECT THE TERMINALS SHOWN BELOW
+
-
D.C. OUTPUT (LOCAL SENSING)
*
REPLACE THIS LINK BY EXTERNAL FUSE WHEN OVERVOLTAGE PROTECTION PROVIDED (SEE FIG.4 FOR RATING)

FIG. 5 - MAINS CONNECTIONS - D.C. CONNECTIONS FOR LOCAL SENSING

MAINS INPUT CONNECTIONS

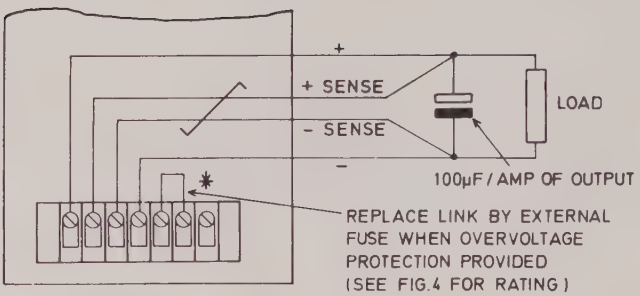
Mains input connections are shown in Fig.5.

OUTPUT CONNECTIONS - LOCAL SENSING

This is the simplest method of using the unit and is shown in Fig.5. Fine adjustment of the output voltage may be carried out by means of the potentiometer R1 on the control board (accessible from the top or side of the unit). An external d.c. fuse is not normally required unless the unit is provided with overvoltage protection.

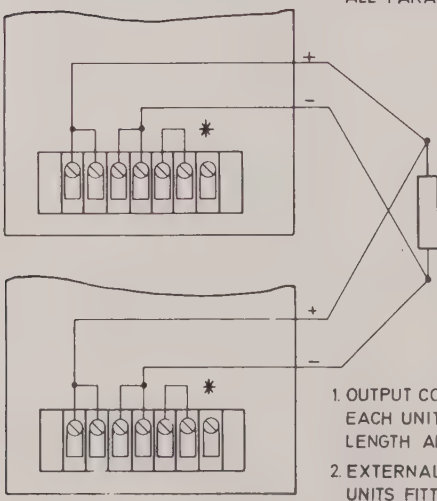
D.C. FUSING AND OVERVOLTAGE PROTECTION

A d.c. fuse of the correct rating may be connected in place of the link shown in Fig.5. For units provided with overvoltage protection it is essential to fit such a fuse as back-up protection. Operation of the over-voltage circuit will normally operate the overcurrent protection circuit. In the event of the overcurrent protection circuit failing, the d.c. fuse will provide back-up protection. The correct value for the fuse is given in Fig.4.



REMOTE SENSING
Fig. 6 (a)

A.C. MAINS SUPPLY MUST BE SIMULTANEOUSLY SWITCHED TO ALL PARALLELED UNITS



DIRECT PARALLEL OPERATION
Fig. 6 (b)

NOTES

1. OUTPUT CONNECTIONS FROM EACH UNIT TO BE EQUAL LENGTH AND CROSS-SECTION
2. EXTERNAL FUSE REQUIRED FOR UNITS FITTED WITH OVERVOLTAGE PROTECTION (SEE FIG. 4)
3. CSR1 ON ANY UNIT MUST BE CAPABLE OF CARRYING FULL SHORT-CIRCUIT LOAD (SEE PAGE 18)

FIG. 6 - REMOTE SENSING AND DIRECT PARALLEL OPERATION

OUTPUT CONNECTIONS – REMOTE SENSING

Connections are shown in Fig.6(a). The sensing leads should be a twisted pair to minimise their self inductance. An alternative method is to use the screens of two coaxial cables for the power leads and their cores for the appropriate sense leads.

Additionally, the capacitor shown in Fig.6(a) must be connected across the load. It should be 100μF per ampere of output current and be capable of withstanding 150% of the rated output voltage.

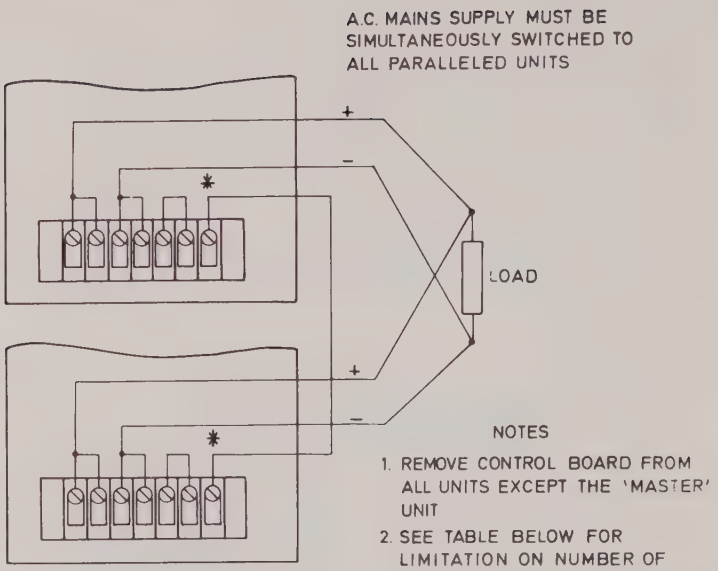
If the output leads are longer than 6ft, further modification may be necessary to prevent parasitic oscillation of the output. In this event removal of the output capacitors C3 from the power supply will usually effect a cure.

OUTPUT CONNECTIONS – DIRECT PARALLEL OPERATION

This is the simplest method of parallel operation and requires only that the units be set closely to the same nominal output voltage and connected as shown in Fig.6(b). Any number of units may be paralleled by this method and these need not necessarily have the same current rating.* Local or remote sensing may be used.

The disadvantages of this method are that the units will not equally share the load current and the output characteristic will have step changes in voltage which are equal in amplitude to the differences between the set-up voltages of individual units.

*See Overvoltage Protection


A.C. MAINS SUPPLY MUST BE SIMULTANEOUSLY SWITCHED TO ALL PARALLELED UNITS
+
−
LOAD
+
−
NOTES
1. REMOVE CONTROL BOARD FROM ALL UNITS EXCEPT THE 'MASTER' UNIT
2. SEE TABLE BELOW FOR LIMITATION ON NUMBER OF UNITS
3. SEE ALSO FIG. 6 (b) NOTES 1 TO 3

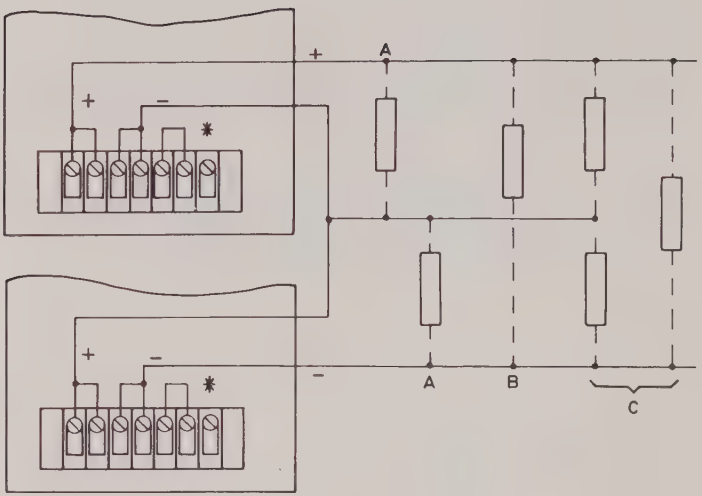
UNIT CODE	RATED MAX OUTPUT		MAX No. OF UNITS (MASTER AND SLAVES)
	I	V	
MQ 0 5A	0 5	16	2
MQ 0 5B	0 5	30	1
MQ 1A	1	16	1
MQ 1B	1	30	4
MQ 2A	2	16	3
MQ 2B	2	30	2
MQ 3A	3	16	2
MQ 3B	3	30	1
MQ 5A	5	16	1
MQ 5B	5	30	2
MQ 10A	10	16	1

FIG. 7 MASTER / SLAVE PARALLEL OPERATION

OUTPUT CONNECTIONS – MASTER/SLAVE PARALLEL OPERATION

Connections are shown in Fig.7. Before this mode of operation can be used a lead must be connected between the * terminal of the output connecting block and pin f of the "mother board" as shown in Figs. 9, 10 and 11, in all units to be paralleled. The plug-in control boards must then be removed from all units except the "master" unit. Local or remote sensing may be used.

This method of parallel operation has the advantage that units share current more closely and the output voltage is stepless, but the number of units which may be connected in parallel is limited to the numbers shown in Fig.7. Where overvoltage protection is also fitted, refer to the section on overvoltage protection.



A. LOAD BETWEEN LINES ONLY FULL OUTPUT CURRENTS AVAILABLE.

B LOAD ACROSS OUTER LINES OUTPUT CURRENTS LIMITED TO 30 - 40 % OF FULL RATED OUTPUT (UNLESS SPECIALLY MODIFIED)

C. COMBINED LOADS BETWEEN LINES AND ACROSS OUTER LINES. FULL OUTPUTS CURRENTS AVAILABLE PROVIDED NOT MORE THAN 15 % OF OUTPUT CURRENT IS REQUIRED FOR LOAD ACROSS OUTER LINES (UNLESS SPECIALLY MODIFIED).

NOTES.

1. EXTERNAL FUSE REQUIRED FOR UNITS FITTED WITH OVERVOLTAGE PROTECTION (SEE FIG. 4).

2. A.C. MAINS SUPPLY SHOULD BE SIMULTANEOUSLY SWITCHED TO ALL UNITS CONNECTED IN SERIES.

FIG. 8 - SERIES OPERATION OF UNITS

OUTPUT CONNECTIONS - SERIES OPERATION

Connections are shown in Fig.8 but the maximum permissible output current will depend on the method of connection of the load. Units having different output voltage ratings may be connected in series.

Method A

With the loads applied between lines only, each unit supplies a separate load and current does not flow between units. Full output is obtainable

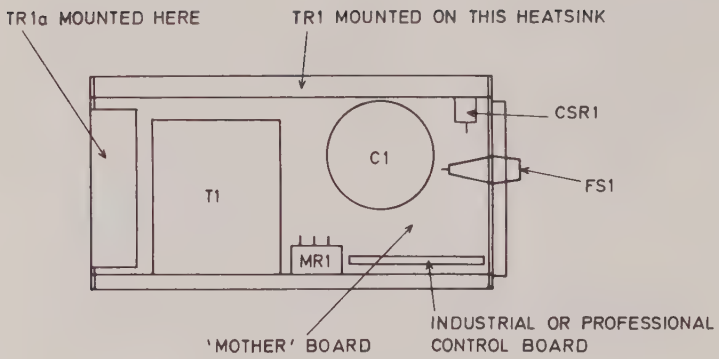
Method B

With the loads connected between the outer lines only, the total current flows through both units. Unless the load current is restricted to about 30-40% of full rated output the load line of the combined units may fall outside the fold-back overcurrent characteristic of one of the units, preventing one of the outputs being established at switch on, both units having the same rated output current.

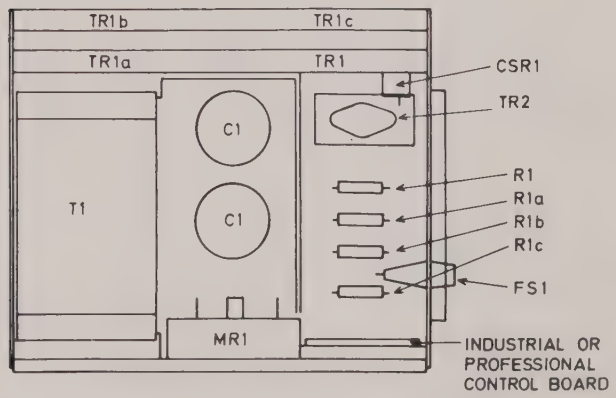
Method C

This is a mixture of A and B and is satisfactory so long as only 15% of the load current is consumed by the load across the lines, both units having the same rated output current.

Several methods exist whereby the above limitations can be overcome for a given application. They entail some internal modifications and our Applications Department should be consulted if full output current is required for any load configuration.



(a) COMPONENT LAYOUT FOR MQ 0·5A TO MQ 5A (TYPICAL)



(b) COMPONENT LAYOUT FOR MQ 5B AND MQ 10A

FIG. 9 - COMPONENT LAYOUTS

PROGRAMMABLE UNITS

On such units, RC (Figs. 10 and 11) is not fitted and a lead is connected between the * terminal of the output connecting block and pin b of the "mother board" (see Fig.9).

An external resistor connected between * and - (sense) will set the output voltage anywhere within the voltage range of the unit at the rate of 1 volt for every 300 ohms of resistance. Note that the resistor must be a high stability type, otherwise the temperature coefficient of the power supply will be degraded.

Any switching in the programming circuit should be make-before-break, since an open circuit will cause the output voltage to rise to about the maximum value of the raw d.c. voltage at the reservoir capacitor. As a safeguard units are delivered with a shorting link between * and - (sense) which has the effect of holding the output voltage at zero should power be applied to the unit as received. The link must be replaced by the programming resistor before putting the unit into service. The wiring between the power supply and the programming resistor must be a twisted pair to minimise self-inductance and must be laid in such a way that it is not affected by stray fields.

Programmable units may be connected for local or remote sensing but are not suitable for direct parallel operation.

If rate of change of output voltage (slew rate) is important, consult our Applications Department.

Note that the output current of a programmable unit may require de-rating depending upon the maximum programmed voltage. Reference should be made to Fig.1.

CURRENT OVERLOAD PROTECTION

Fold-back current limiting from 110% of full load to about 15% of full load at short circuit is normally provided, the circuit recovering automatically when the overload is removed. (See Fig.1A). The current limit value may be varied from its preset value by the printed circuit potentiometer R2. If constant current limiting is provided care must be taken that the output current limitation imposed by the preset output voltage level is observed. (See Fig.1B and 1C).

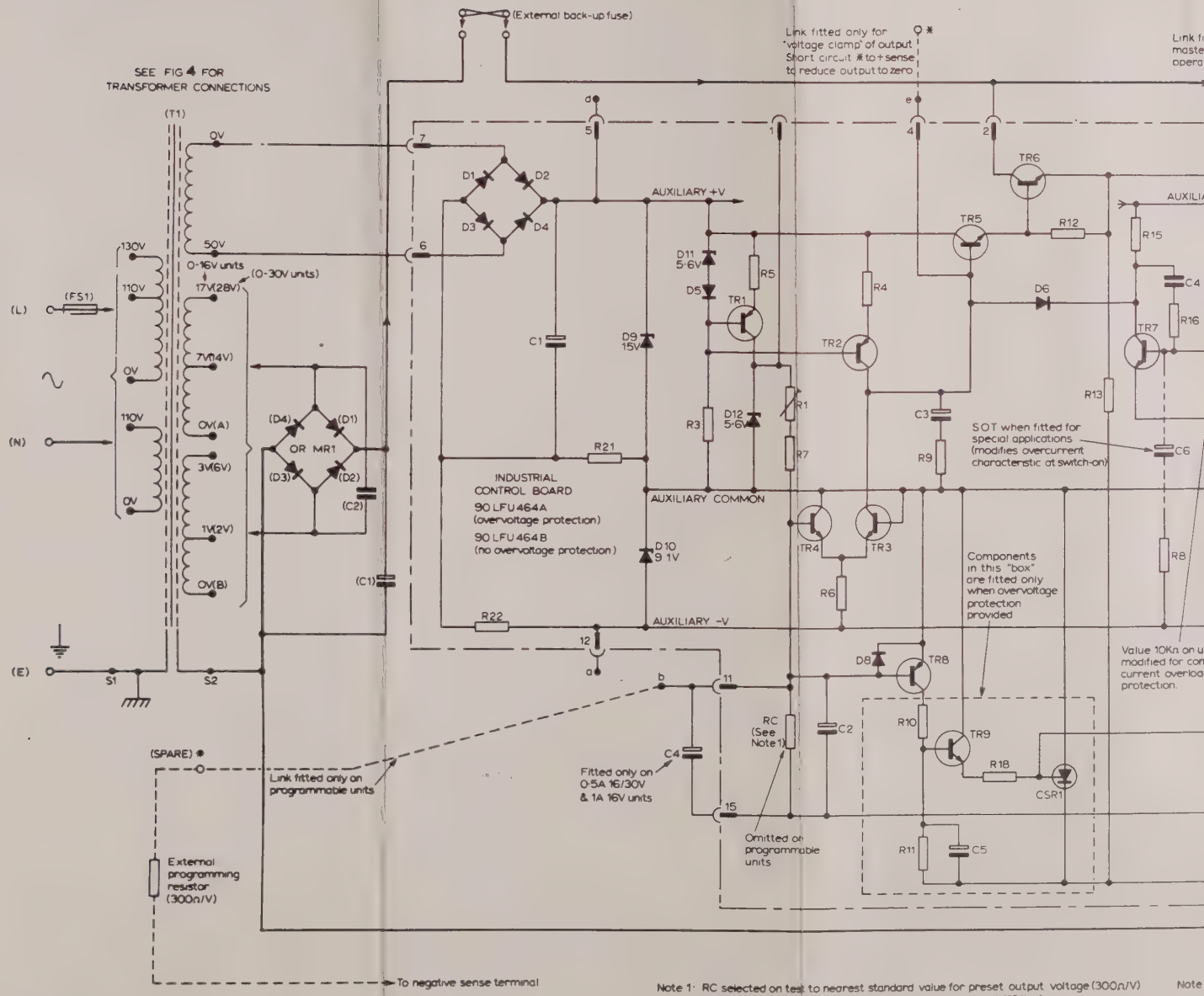
When manual reset is provided the circuit does not recover until the supply mains have been switched off and on again. In this mode, which can be provided only on Professional units, the overcurrent circuit provides a 150ms delay before tripping.

OVER VOLTAGE PROTECTION

The circuit fires a crowbar thyristor when the voltage across the output terminals exceeds approximately 110% + 0.5V of the preset or programmed output voltage. The response time of the overvoltage circuit is typically $\frac{1}{2V_o}$ ms. The current taken by the thyristor will either cause the overcurrent circuit to reduce the output voltage or will blow the back-up fuse which must be fitted as shown in Fig.5.

On units up to 2A the thyristor is fitted on the plug-in control card. Above 2A rating a larger stud-mounted thyristor is fitted to the extruded heatsink.

The current taken by the thyristor should not exceed 0.6A continuous in units rated up to 2A and should not exceed 10A continuous in units rated above 2A unless agreed by our Applications Department. This constraint restricts the number of units which may be paralleled and can preclude the fitting of overvoltage to units with constant current limiting.



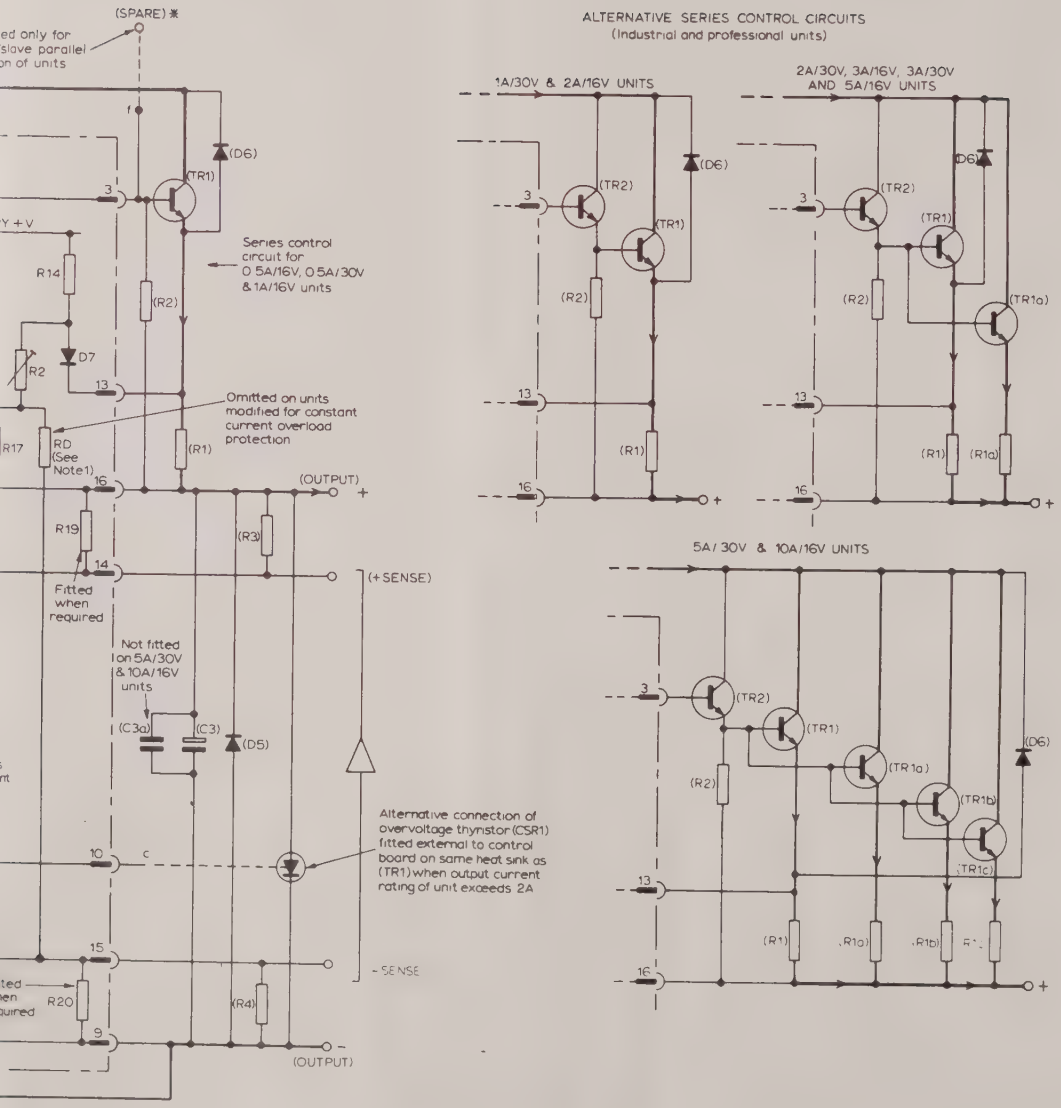
Note 1: RC selected on test to nearest standard value for preset output voltage (300Ω/V)
RD selected on test to start current foldback limiting at 110% of max rated output current (at specified preset output voltage) (1KΩ/V)

Note 2: Lettered tags (e.g. —●f) are part of "mother board" carrying socket for printed circuit connector pins of control board

Note

Note

Fig.10



SOT denotes "Selected On Test"

10 Connections shown thus are control card connector pin numbers

Circuit Diagram — Industrial Units

TECHNICAL DESCRIPTION (FIGS. 10 & 11)

General

Professional and Industrial units differ only in the type of control board fitted. The remainder of the circuit consists of a conventional full-wave rectifier and series control transistor, or transistors, (TR1, TR1a–TR1c). An additional current amplifier (TR2) is also introduced in the higher current units. A current sensing resistor (R1) is provided for the overcurrent protection circuit on the control board. (D6) prevents reverse polarity across the series transistor(s) and (D5) protects the unit against reverse currents.

INDUSTRIAL CONTROL BOARD (FIG.10)

An auxiliary supply floats +15V above and –9.1V below the + sense rail and provides power for the control circuits.

The output voltage is sampled at the base of the long-tailed pair amplifier TR4 and any variations from the level preset by R1, R7 and RC cause the base drive of TR5, TR6 and the series control transistor (TR1) to alter in such a way as to correct the tendency of the output voltage to vary.

TR2 provides a constant current high impedance load for TR3 and TR1/D12 provides a stable positive supply for the sampling divider R1, R7 and RC. R1 permits a small variation of the voltage preset by RC or the external programming resistor.

The output current flowing through the current sensing resistor (R1) produces a potential drop which effectively appears between the emitter–base junction of TR7 via R2. TR7 is held–off by the resistors R17 or RD until the output current rises to 110% of full load current. At this point TR7 begins to conduct and turn of TR5, TR6 and the series control transistor. The output voltage falls and the current through RD is reduced, causing greater conduction in TR7. The output voltage therefore falls rapidly to zero for short–circuit conditions at which point the voltage across RD is approximately 0.5V. Short–circuit current is then determined by the value of R17 or RD. The circuit recovers automatically when the overload is removed and the potential drop across the current sensing resistor (R1) is restored to normal. R2 enables the overload point to be adjusted.

When constant–current protection is provided RD is omitted and R17 is fitted (value 10KΩ) to fix the short–circuit current at the overload value.

The error control voltage at the base of TR4 is also applied to the base of TR8 and if the output voltage increases above 110% + 0.5V of the preset or programmed value, the excessive error voltage causes TR8 and TR9 to conduct and fire the crowbar thyristor CSR1. CSR1 short-circuits the output and either triggers the overcurrent protection circuits or blows the external back-up fuse.

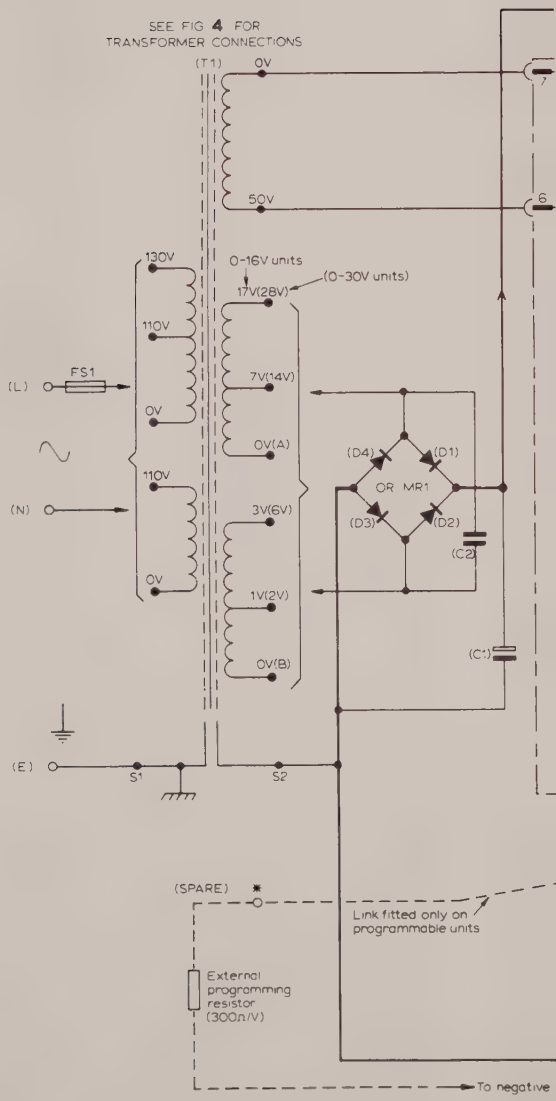
PROFESSIONAL CONTROL BOARD (FIG.11)

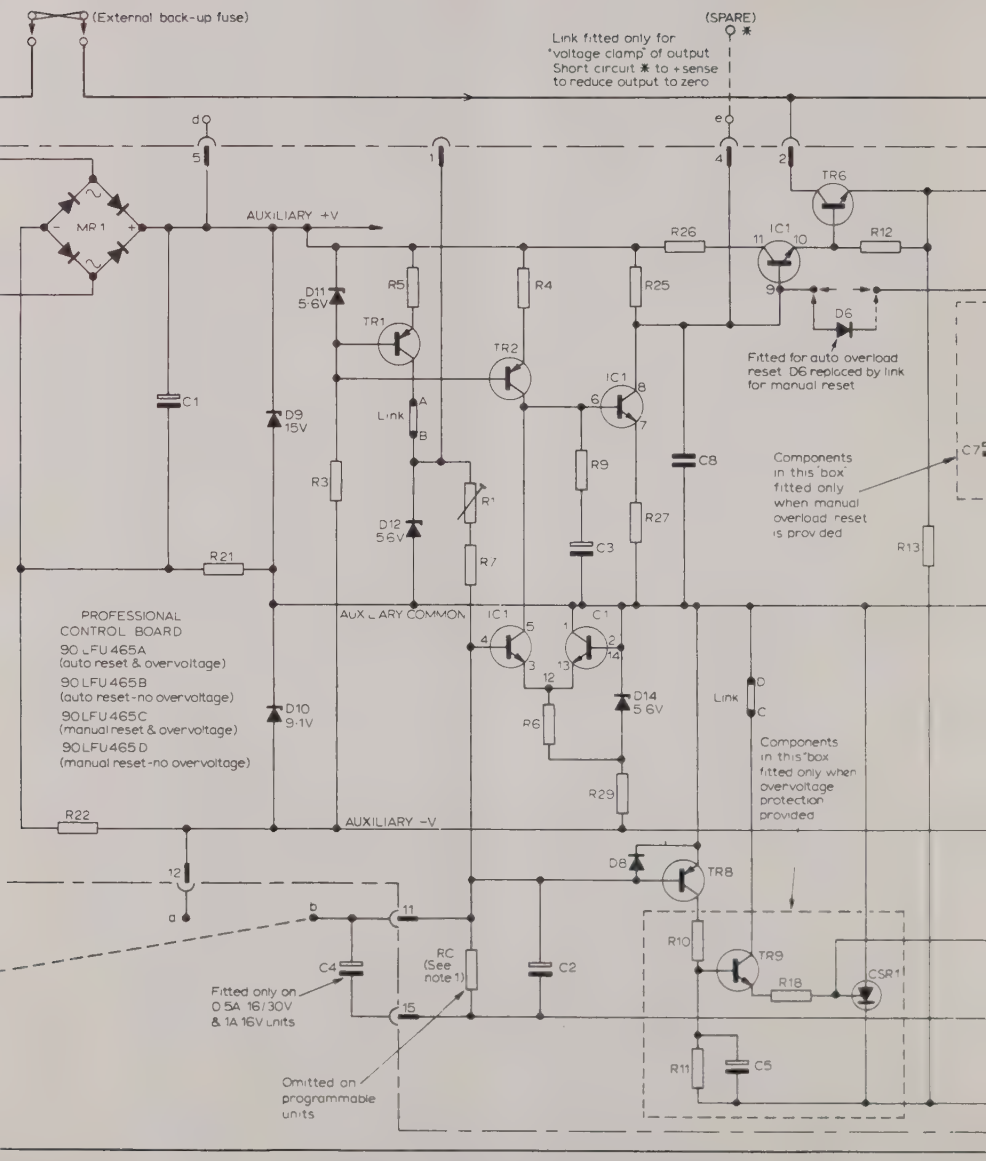
The circuit is very similar to that of the Industrial control board. A monolithic integrated circuit IC1 provides four of the transistors in a circuit designed to provide a higher stabilisation ratio and also manual reset of the overcurrent protection circuit.

An extra transistor IC1-6, 7, 8 is used as an inverting amplifier driven from the opposite side of the long-tailed pair in order to increase the gain of the control circuit. With these exceptions, the description of the control circuit, overcurrent protection circuit with automatic reset and the overvoltage circuit, is identical to that of the Industrial unit.

The Professional unit, however, has provision for manual reset of a current overload and the alterations to the circuit are shown in Fig.11.

TR11 is cross-coupled with TR7 in a complementary bistable circuit so that when TR7 draws current via R28 and switches TR11 into conduction, the rise in potential at TR11 collector holds TR7 conducting even when the overload has been removed. To reset the unit, the mains supply must be switched off and then on again.


SEE FIG 4 FOR TRANSFORMER CONNECTIONS
(T1)
0V
50V
7
6
130V
110V
0V
110V
0V
0-16V units
(0-30V units)
17V(28V)
7V(14V)
0V(A)
3V(6V)
1V(2V)
0V(B)
FS1
(L)
(N)
(E)
S1
S2
(D4)
(D1)
OR MR1
(D3)
(D2)
(C2)
(C1)
(SPARE)
Link fitted only on programmable units
External programming resistor (300Ω/V)
To negative



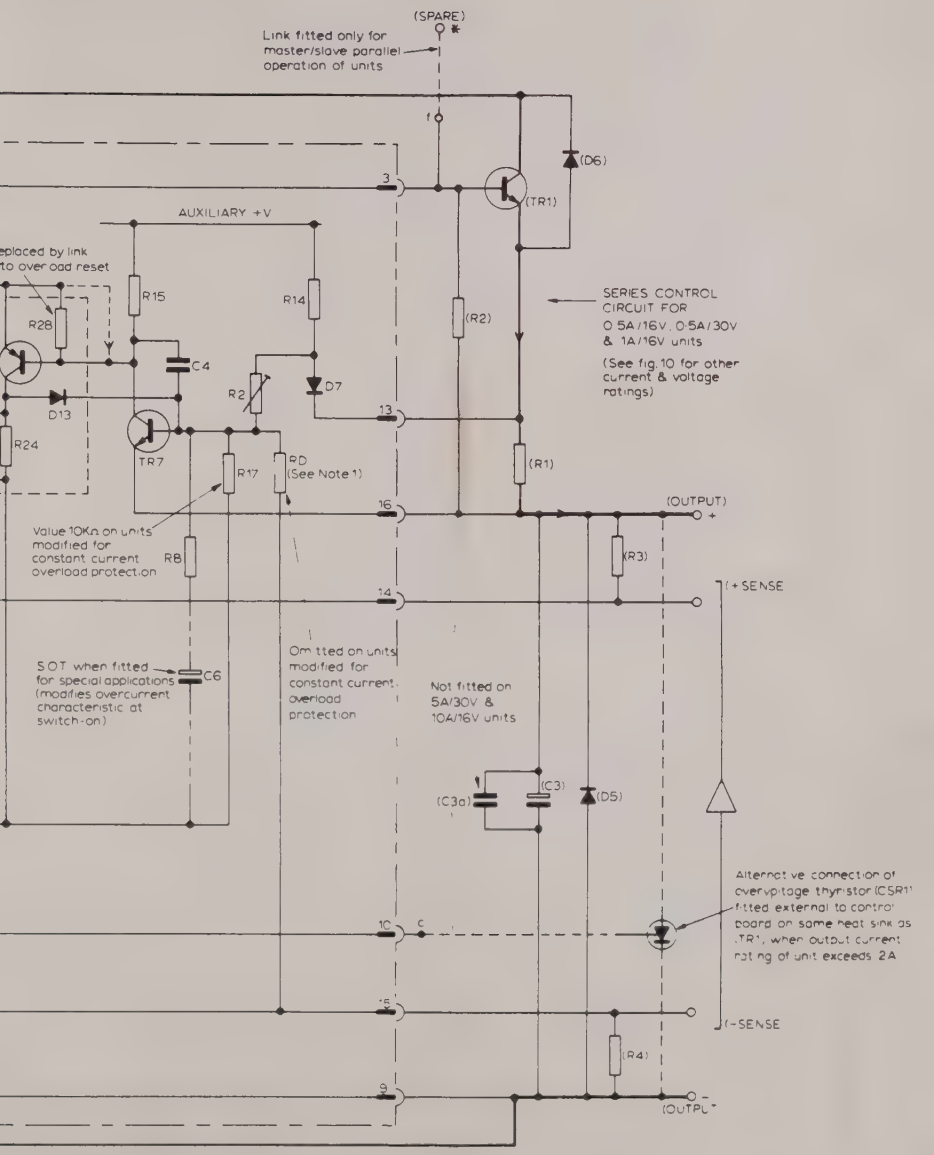
ense terminal

Note 1. RC selected on test to nearest standard value for preset output voltage (300Ω/V). RD selected on test to start current foldback limiting at 110% of max rated output current (at specified preset output voltage) (1KΩ/V)

Note 2 Lettered tags (e.g —●f) are part of 'mother board' carrying socket for printed circuit connector pins of control board

Note 2 S

Note 4 —



Circuit Diagram – Professional Units Fig.11

MQ 'A' TYPES 0-16V D.C.

TAP COMBINATION	RMS SECONDARY VOLTS
(0-1)	1.2
(1-3)	2.3
(0-3)	3.5
(0-7) - (0-3)	4.9
(0-7) - (1-3)	6.1
(0-7) - (0-1)	7.2
(0-7)	8.4
(0-7) + (0-1)	9.6
(7-17)	9.9
(0-7) + (1-3)	10.7
(7-17) + (0-1)	11.1
(0-7) + (0-3)	11.9
(7-17) + (1-3)	12.2
(7-17) + (0-3)	13.4
(0-17) - (0-3)	14.5
(0-17) - (1-3)	15.7
(0-17) - (0-1)	16.8
(0-17)	18
(0-17) + (0-1)	19.2
(0-17) + (1-3)	20.3
(0-17) + (0-3)	21.5

MQ 'B' TYPES 0-30V D.C.

TAP COMBINATION	RMS SEC'Y VOLTS
(0-2)	2.4
(2-6)	4.8
(0-14) - (0-6)	6.8
(0-6)	7.2
(0-14) - (2-6)	9.2
(0-14) - (0-2)	11.6
(0-14)	14
(0-14) + (0-2)	16.4
(0-14) + (2-6)	18.8
(0-28) - (0-6)	20.8
(0-14) + (0-6)	21.2
(0-28) - (2-6)	23.2
(0-28) - (0-2)	25.6
(0-28)	28
(0-28) + (0-2)	30.4
(0-28) + (2-6)	32.8
(0-28) + (0-6)	35.2

APPROX. SECONDARY VOLTS AT FULL LOAD WITH 240V INPUT TO PRIMARY

MAINS TRANSFORMER SECONDARY CONNECTIONS

D.C. OUTPUT VOLTS	RC TR5 ±2%	RD TR5 ±2%	SEC. VOLTS (RMS)	D.C. OUTPUT VOLTS	RC TR5 ±2%	RD TR5 ±2%	SEC. VOLTS (RMS)
1	300	1.5K	6	17	5.1K	18K	21
2	620	2.2K	8	18	5.6K	18K	22
3	910	3.3K	9	19	5.6K	20K	23
4	1.2K	3.9K	10	20	6.2K	20K	24
5	1.5K	5.6K	11	21	6.2K	22K	25
6	1.8K	6.2K	12	22	6.8K	22K	26
7	2.2K	6.8K	13	23	6.8K	24K	27
8	2.4K	8.2K	14	24	7.5K	24K	27
9	2.7K	9.1K	15	25	7.5K	24K	28
10	3K	10K	15	26	7.5K	27K	29
11	3.3K	10K	16	27	8.2K	27K	29
12	3.6K	12K	17	28	8.2K	27K	30
13	3.9K	13K	18	29	9.1K	30K	31
14	4.3K	15K	19	30	9.1K	30K	32
15	4.3K	15K	19				
16	4.7K	16K	20				

PRESET VALUES OF RC & RD & TRANSFORMER SECONDARY VOLTAGES

VALUES OF RC & RD, TR1 SECONDARY VOLTAGES AND CONNECTIONS FIG. 12
(INDUSTRIAL AND PROFESSIONAL UNITS)

UNIT CODE MQ**	R1 - R1C	R2	R3 R4	C1	C2	C3
0.5A	1 5% 3W	3.3k 2%	100 2%	2200 40V	0.47 63V	47 25V
0.5B	1 5% 3W	3.3k 2%	100 2%	1000 63V	0.47 160V	68 63V
1A	0.5 5% 3W	3.3k 2%	100 2%	3300 40V	0.47 160V	68 63V
1B	0.5 5% 3W	3.3k 2%	100 2%	1500 63V	0.47 160V	68 63V
2A	0.5 5% 3W	3.3k 2%	100 2%	4700 40V	0.47 160V	100 40V
2B	0.5 5% 3W	3.3k 2%	100 2%	1650 + 1650 63V	0.47 160V	100 40V
3A	0.5 5% 3W	3.3k 2%	100 2%	3400 + 3400 40V	0.47 160V	470 + 100 40V
3B	0.5 5% 3W	3.3k 2%	100 2%	2350 + 2350 63V	0.47 160V	470 + 100 40V
5A	0.27 5% 7W	1.5k 2%	100 2%	5000 + 5000 40V	0.47 160V	470 + 100 40V
5B	0.5 5% 3W	330 2%	47 2%	2350 + 2350 63V	0.47 160V	470 + 100 40V
10A	0.27 5% 7W	330 2%	47 2%	5000 + 5000 40V	0.47 160V	470 + 100 40V

NOTE: ALL TRANSISTORS ARE TYPE 2N 3055

TABLE OF COMPONENTS NOT ON CONTROL BOARD
(INDUSTRIAL AND PROFESSIONAL UNITS)

FIG.13

UNIT CODE MQ**	C3A	C4	D1 - D6	MR1	T1	CSR1 (WHEN FITTED)
0.5A	.022 160V	6.8 40V	IN4003	-	70GACR1405AEK	-
0.5B	.022 160V	6.8 40V	IN4003	-	70GACL1405AEL	-
1A	.022 160V	6.8 40V	IN4003	-	70GACL1405AEM	-
1B	.022 160V	-	IN4003	-	70GADM1405AEN	-
2A	.022 160V	-	IN5401	-	70GADM1405AEP	-
2B	.022 160V	-	IN5401	-	70GAAP1406ACZ	-
3A	0.47 160V	-	IN5401	-	70GAAP1406ADA	20TB1
3B	0.47 160V	-	IN5401	-	70GADN1406ADB	20TB1
5A	0.47 160V	-	IN5401	70USD13099AAO	70GADN1406ADC	20TB1
5B	-	-	12F10	70USD13099AAO	70GCB2406AEG	20TB1
10A	-	-	12F10	70USD13099AJO	70GCBP2406AEF	20TB1

SEE FIG.4 FOR RATINGS OF FS1

TABLE OF COMPONENTS NOT ON CONTROL BOARD (CONT'D)
(INDUSTRIAL AND PROFESSIONAL UNITS)

FIG.14

CIRCUIT REF.	TYPE	VALUE	TOL. ± %	RATING
RESISTORS				
R1	WMP/PC	330		
R2	WMP/PC	1k		
R3,7,12	TR5	1.5k	2	
4	TR5	8.2k	2	
5	TR5	620	2	
R8,11,13	TR5	10k	2	
R9	TR5	470	2	
RC,RD	TR5	*††	2	
R10	TR5	1k	2	
R14	TR5	6.8k	2	
R15	TR5	5.6k	2	
R16	TR5	100	2	
R17	TR5	†† –	2	
R18	TR5	47	2	
R19,20	†TR5	47		
R21	C3A	2.2k	5	
R22	TR5	5.1k	2	
CAPACITORS				
C1	G1244-50N-100S	50		100V
C2	015 18108	1		63V
C3	(for MQ 0.5A) (to MQ3B Units)	1000p		30V
	(for MQ 5A to) (MQ 10A Units)	2000p		
C4		1000p		30V
C5	ITT TAG	0.47		35V
C6	015	**		
TRANSISTORS				
TR1,2	70CST32001AAA	(BCY72)		
TR3,4,5 & 7	70CST31001AAA	(BC108)		
TR6,9	70CST31001AAC	(2N3945)		
TR8	70CST32001AAC	(BFX30)		
THYRISTORS				
CSR1	70CST39001AAA	(40654)		
DIODES				
D1-5,8	70CSD13001AAD	(IN4003)		
D6,7	69DI008	(IN4148)		
D9	BZX61/C15			
D10	70CSD23001AAC	(BZY88/C9V1)		
D11,12	70CSD23001AAE	(BZY88/C5V6)		

* See Fig.14 for preset values of RC and RD

** Selected on test when fitted for special applications

† Fitted when required

†† On units provided with constant current overload protection RD is omitted and R17 (10K) is fitted.

FIG.15 TABLE OF COMPONENTS FITTED TO INDUSTRIAL CONTROL BOARD

ITT Components Group Europe reserve the right to make design and component changes without notice. Equivalent components may be used in place of those listed.

CIRCUIT REF	TYPE	VALUE	TOL. ± %	RATING
RESISTORS				
R1		500		
R2		†† 1k		
R3,6,26	TR5	3.6k	2	
R4	TR5	8.2k	2	
R5	TR5	620	2	
R7,12	TR5	1.5k	2	
R8,13	TR5	10k	2	
R9	TR5	220	2	
R10	TR5	1k	2	
R11	TR5	10k	2	
R14	TR5	6.8k	2	
R15	TR5	5.6k	2	
R17	TR5	††	2	
R18	TR5	47	2	
R21	CGSC3A	2.2k	5	
R22	CGSC3A	2.7k	5	
R24	TR5	470k	2	
R25	TR5	27k	2	
R27,29	TR5	1k	2	
R28	TR5	8.2k	2	
RC,RD	TR5	*††	2	
CAPACITORS				
C1	GI244-50N-100S	50		100V
C2	015 18108	1		63V
C3	WIMA T.F.M.	.022		160V
C4,8		1000p		30V
C5	ITT TAG	0.47		35V
C6	015	**		
C7	ITT TAG	6.8		25V
TRANSISTORS				
TR1,2,11	70CST32001AAA	(BCY72)		
TR6,9	70CST31001AAC	(2N3945)		
TR7	70CST31001AAA	(BC108)		
TR8	70CST32001AAC	(BFX30)		
IC1	Integrated Circuit CA3086			
THYRISTORS				
CSR1	70CST39001AAA	(40654)		
RECTIFIERS				
MR1	Rectifier Bridge WO2			
DIODES				
D6,13	BAX13			
D7,8	70CSD13001AAD	(IN4003)		
D9	BZX61/C15			
D10	70CSD23001AAC	(BZY88/C9V1)		
D11,12,14	70CSD23001AAE	(BZY88/C5V6)		
D12	† 70CSD23001AAF	(IN823A)		

* See Fig.14 for preset values of RC and RD

** Selected on test when fitted for special applications.

† -Fitted when low temperature coefficient is specified.

†† On units provided with constant current overload protection RD is omitted, R17 is fitted (value 10k) auto-reset or 39k (manual reset) and R2 increased to 5k (manual reset only).

FIG.16 TABLE OF COMPONENTS FITTED TO PROFESSIONAL CONTROL BOARD

ITT Components Group Europe

Standard Telephones and Cables Limited

Rectifier Division,
Edinburgh Way, Harlow, Essex.

Telephone: Harlow 26811 Telex: 81146

MP MASTER

MA23297